Quantified Measurement of the Tilt Effect in a Family of Café Wall Illusions

Nasim Nematzadeh, David M. W. Powers, Flinders University of South Australia

This abstract explores the tilt effect in a family of Café Wall illusions using a Classical Gaussian Receptive Field model (CRF). Our model constructs an intermediate representation called edge map at multiple scales (Fig. 1) that reveals tilt cues and clues involved in the illusory perception of the Café Wall pattern. We investigate a wide range of parameters of the stimulus including mortar width, luminance, tiles contrast, and phase of the tile displacement (the stimuli in Fig. 2) [1]. We show that this simple bioplausible model, simulating the contrast sensitivity of the retinal ganglion cells, can not only detect the tilts in this pattern but also allows us to predict the strength of the illusion and quantify the degree of tilt. We embed the DoG model in a processing pipeline using Hough space for quantitative measurement of tilt angles in the edge map to compare them with the tilt perceived by a human observer.

A systematic approach was designed as a classifier (below diagram) for the tilt effect that is described based on the horizontal mean tilts detected at fine scale close to the mortar size, that reflect the ‘persistence of mortar cues’ (PMC) across multiple scales of the edge maps. Even though the results of our simulations are consistent with previous psychophysical findings reported in the literature across the full range of Café Wall variations tested, it is a priority in our future study to run psychophysical experiments to confirm the precise quantitative predictions made by our model.

| FTE | Foveal Tilt Effect | Detected mean tilts at $\sigma_t = 4$ that is the finest scale close to the mortar size
| RMT | Range of Mean Tilts | Detected mean tilts (fine to medium scales)
| PMC | Persistence of Mortar Cues | Persistence of mortar cues in the edge map across multiple scales, from the finest scale to the maximum scale with existing mortar cues (Twisted Cord elements)
| STR | Illusion Strength | The strength of the tilt effect predicted by the proposed systematic approach (the right diagram) for the samples tested

Fig. 1. Binary edge map at 7 scales overlayed by the detected Hough lines in Green ($MW = 8$ px)

Fig. 2. Predictions of the strength of the tilt effect (STR in Orange) for a family of Café Wall illusions. We colour-coded the proposed systematic approach of the decision making (the top diagram) and the corresponding values in the tables (key factors) with the results provided in the figure for an easier follow-up.